

DISTRIBUTION OF *ONCOMELANIA HUPENSIS* IN THE NAPU VALLEY OF CENTRAL SULAWESI, INDONESIA

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INTRODUCTION

Oriental schistosomiasis has long been known to be endemic to Central Sulawesi, Indonesia (Müller and Tesch, 1937). Recently, studies of schistosomiasis transmission in the Lindu Valley, Central Sulawesi were initiated and the intermediate host of *Schistosoma japonicum* was discovered (Carney *et al.*, 1973) and subsequently described as a new subspecies of *Oncomelania hupensis*, namely, *O. h. lindoensis* (Davis and Carney, 1973). In 1972 schistosomiasis was found to be highly endemic among residents of North Lore District, Napu Valley, Central Sulawesi (Carney *et al.*, 1974a). Our report defines the known distribution of the Napu geographical strain of *O. hupensis* throughout North Lore District, Napu Valley, and reports on isolation of *S. japonicum* from the Napu strain of *O. hupensis* by animal exposures. Napu Valley is illustrated in relation to other areas of Central Sulawesi which have been surveyed during the past four years (Fig. 1). Geological and geographical data of this area were described in a previous paper (Carney *et al.*, 1974a).

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MATERIALS AND METHODS

Suitable habitats along primary trails traversing North Lore District of Napu were searched for *O. hupensis*. No attempt was made to locate colonies in undisturbed areas, nor were potential habitats more than 1 km from main trails or villages searched. Some oncomelanids were relaxed with 0.5% Nembutal^(R), fixed 24 hours in 10% formalin and transferred to 70% ethyl alcohol for storage and subsequent taxonomic confirmation. Other oncomelanids were returned to our laboratory alive, and shed to recover larval schistosomes which were used to expose laboratory raised mice. Adult flukes, recovered from mesenteric veins and liver, were fixed in 10% formalin, stained and mounted on slides for species confirmation.

RESULTS

Cursory surveys of suitable habitats in the North Lore District, Napu Valley revealed 15 colonies of the Napu geographical strain of *Oncomelania hupensis* (Fig. 2). Schistosome cercariae were shed from *O. hupensis* collected at Watumaeta (Focus #4), Wuasa (Focus #5), Alitupu (Focus #8) and Kaduwaa (Focus #13). White mice, subsequently exposed to these cercariae, developed patent infections of *S. japonicum*. Oncomelanids from the remaining foci were not examined for schistosomes.

Habitats of *O. hupensis* thus far isolated in the Napu Valley were all situated in open,

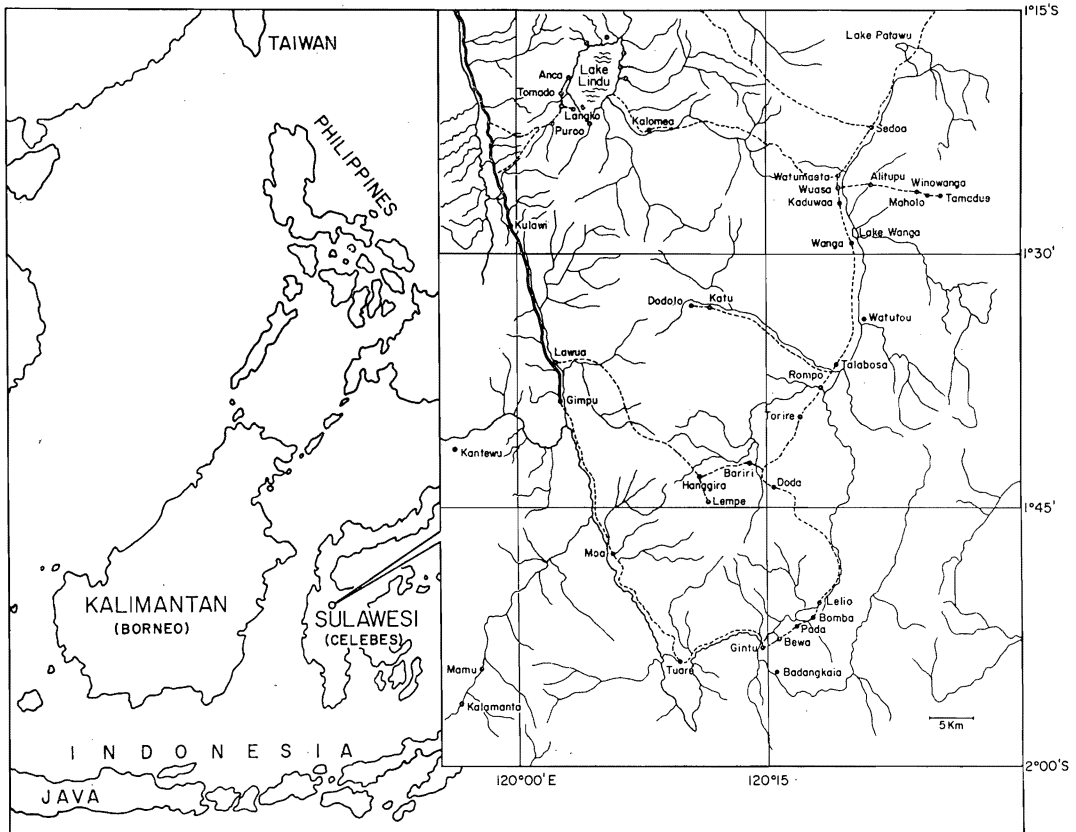


Fig. 1—Napu Valley area of Central Sulawesi in relation to Lindu Valley, a well known focus of oriental schistosomiasis in Sulawesi, Indonesia.

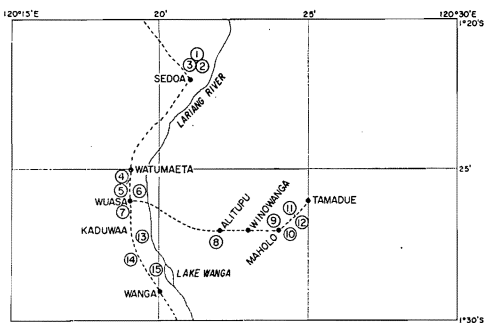
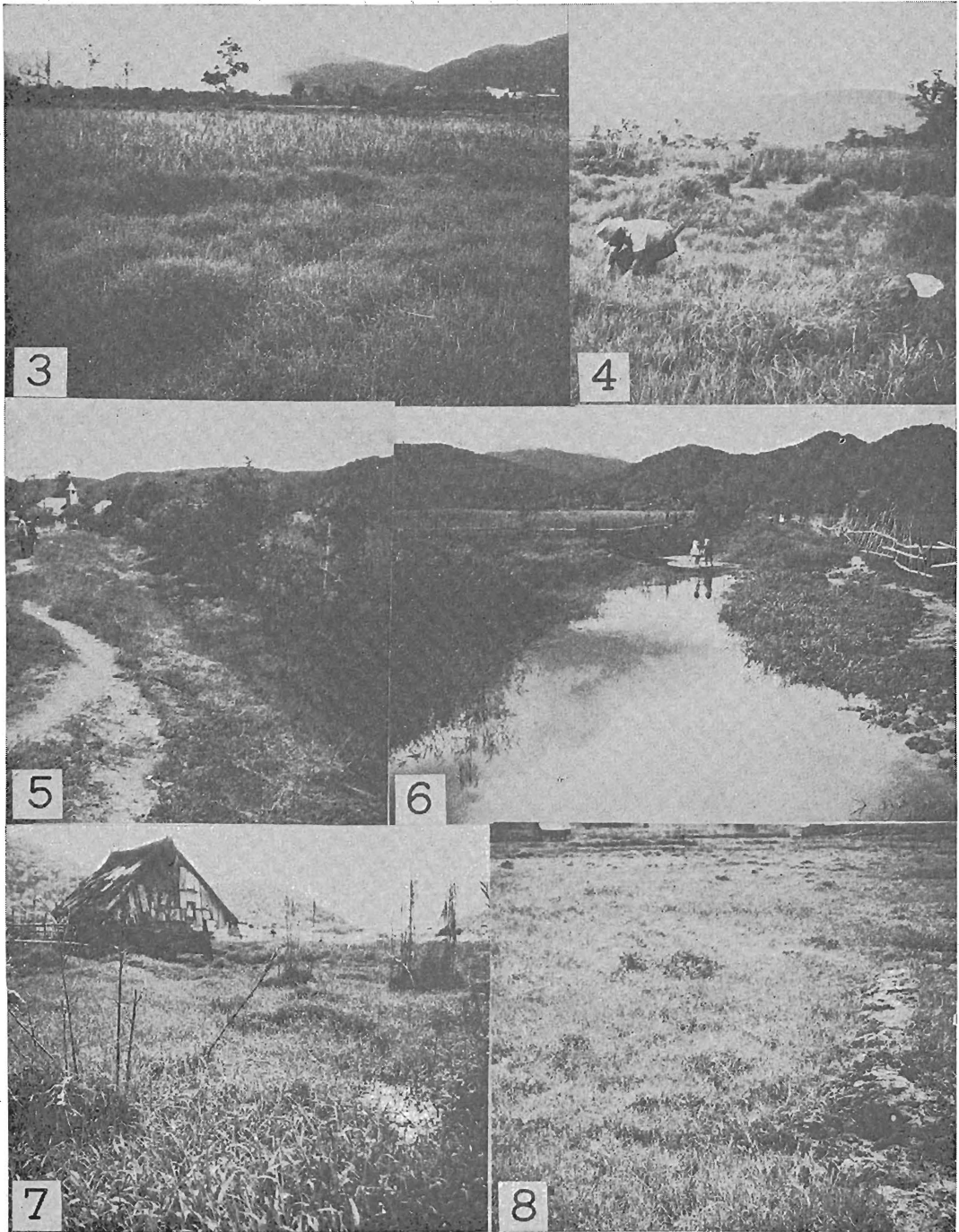


Fig. 2—Precise locations of 15 colonies of the Napu geographical strain of *Oncomelania hupensis* in Napu Valley, Central Sulawesi.

found attached to grass stems or were actively crawling on the silty substrate of these disturbed area foci. The substrate of foci was moistened through channeling of irrigation water into, or from, adjacent rice fields.

Oncomelania hupensis was not found in what appeared to be suitable habitats in other regions of the Lariang River drainage system at similar or lower elevations (Figs. 1 and 9). Areas surveyed included Besoa Valley, North Lore District (1°33' - 1°45' S, 120°07' - 120°20' E) including potential habitats near Talabosa, Torire, Rompo, Dodolo, Katu, Doda, Bariri, Hanggira and Lempe varying in elevation from 1,018 to 1,163 meters; Bada Valley (1°45' - 2°00' S, 120°08' - 120°20' E) includ-

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Figs. 3-8—Oncomelanid habitats in Napu Valley, Central Sulawesi. 3. Focus situated in an abandoned rice field adjacent to actively worked rice field. 4. Focus located in a grassy field adjacent to native cane brakes. 5. & 6. Roadside ditch foci. 7. Focus in field surrounding a native house. 8. An abandoned rice field area in which oncomelanids thrive.

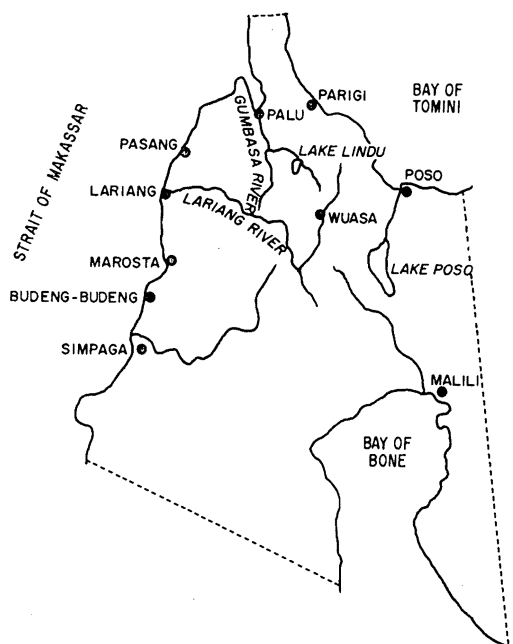


Fig. 9—Map of Central Sulawesi illustrating location of the Lariang River drainage system in respect to the Gumbasa River drainage system. Oriental schistosomiasis is endemic to both drainage systems.

ing potential habitats near Gintu, Badangkaia, Bewa, Pada, Bomba and Lelio varying in elevation from 700 to 800 meters; Gimpu Valley ($1^{\circ}35' - 1^{\circ}40' S$, $120^{\circ}00' - 120^{\circ}05' E$) including potential habitats near Gimpu, elevation 420 meters; Mamu Valley ($1^{\circ}50' - 2^{\circ}00' S$, $119^{\circ}50' - 120^{\circ}05' E$) including potential habitats near Mamu and Kalamanta varying in elevation from 850-1,100 meters; Kantewu Valley ($1^{\circ}42' S$, $119^{\circ}54' E$) including potential habitats near Kantewu, elevation 1,000 meters.

FOCI DESCRIPTIONS

Sedoa, North Lore District ($1^{\circ}22' S$, $120^{\circ}21' E$, elev. 1,127 m): Sedoa focus #1 was situated 1 km northeast of Sedoa in a swampy field covered with dense, short marsh grass (*Ischaemum barbatum*) adjacent to actively worked rice fields. Other mollusks found in associa-

tion with *O. hupensis* were *Radix* sp., *Melanooides* sp. and *Gyraulus* sp.

Sedoa focus #2, located 500 meters southeast of Sedoa focus #1, likewise, was a swampy area of dense, short marsh grass adjacent to actively worked rice fields. *Radix* sp., *Melanooides* sp. and *Gyraulus* sp. were found in association with *O. hupensis*.

Sedoa focus #3 was northwest of Sedoa bordering actively worked rice fields in a swampy area of dense, short marsh grass. This area was not an abandoned rice field, but simply a cleared, yet uncultivated, field. Cane brakes (*Phragmites karka*) grew along one border of this focus. *Opeas* sp. in addition to *Radix* sp., *Melanooides* sp. and *Gyraulus* sp. were found in association with *O. hupensis*. The area served as a pasture for domestic pigs and horses, and buildings for storing rice were constructed on this focus.

Watumaeta, North Lore District ($1^{\circ}25' S$, $120^{\circ}19' E$, elev. 1,063 m): Watumaeta focus #4 was found in a field of dense, tall marsh grass (*Laersia hexandra*), which was frequently flooded during the irrigation of nearby rice fields. The focus was surrounded by cane brakes. Neither humans nor domestic animals appeared to utilize this area. *Radix* sp. was abundant.

Wuasa, North Lore District ($1^{\circ}26' S$, $120^{\circ}19' E$, elev. 1,055 m): Wuasa focus #5 was situated in roadside ditches on both sides of trail from Wuasa to Watumaeta. Grasses were short and sparse. This focus was inundated by run-off waters from adjacent rice fields. *Oncomelania* were found attached to grass stems, tanned leaves and any other available flotsam. Other snails found with *Oncomelania* were *Radix* sp., *Melanooides* sp. and *Thiara* sp. Humans infrequently entered this habitat, but an abundance of animal faeces indicated that it was grazed by domestic herbivores.

Wuasa focus #6 was between actively worked rice fields. *Radix* sp. and *Melanooides* sp.

were common in this moist focus. Animal faeces were scattered about and humans often traversed this focus going to and from their rice fields.

Wuasa focus #7 was situated in a roadside ditch along the trail from Wuasa to Kaduwaa. The grass cover was short and sparse. Oncomelanids, though not abundant, were found attached to grass blades above the running water level and to any flotsam, such as tanned leaves, sticks or branches, in the area. *Indopyrgus* sp., *Radix* sp., *Melanoides* sp. and *Thiara* sp. were found in association with *O. hupensis*.

Alitupu, North Lore District (1°27' S, 120°22' E, elev. 1,038 m): Alitupu focus #8 was an abandoned rice field which, according to the village chief, had not been used for at least five years. It was covered with a mat of dense, short marsh grasses. The substrate was muddy with pockets of standing water. In association with *Oncomelania* the following molluscan species were found: *Radix* sp., *Idiopoma* sp., *Melanoides* sp., *Gyraulus* sp. and *Opeas* sp. This focus was used as a grazing area for domestic animals, but was seldom entered by humans.

Maholo, North Lore District (1°27' S, 120°24' E, elev. 1,063 m): Maholo focus #9 was located in the roadside ditch between Maholo and Winowanga. The grass cover was sparse and short. Irrigation water from adjacent paddy fields kept this roadside ditch moist throughout the year. Domestic animals grazed the area.

Maholo focus #10 was found on a marsh grass field surrounded by native cane brakes. The substrate was moist and standing pockets of water were frequently found. *Oncomelania* were also found in an actively worked rice field adjacent to one border. *Melanoides* sp. and *Radix* sp. were found in association with *Oncomelania*. Horses grazed this focus and

it was crossed by men working in adjacent rice fields.

Tamadue, North Lore District (1°26' S, 120°25' E, elev. 1,066 m): Tamadue focus #11, located in an abandoned rice field, was large, approximately 1,500 meters long and 200 meters wide, and covered by a dense mat of high, marsh grasses. Many small ponds were scattered through this focus. Cane brakes bordered the focus except on the side adjacent to trail from Maholo to Tamadue. A dense oncomelanid population was found actively crawling over the muddy soil together with *Radix* sp., *Idiopoma* sp. and *Melanoides* sp. This focus was used as a pasture for domestic animals, especially horses.

Tamadue focus #12 was an abandoned series of rice fields along the trail between Maholo and Tamadue. It was also large, 1,500 meters long and 200 meters wide. Marsh grasses were dense and tall. Cane brakes bordered the focus except the side adjacent to the trail. Oncomelanids were found in association with *Radix* sp., *Idiopoma* sp. and *Melanoides* sp. Cows, horses and other domestic animals grazed this focus.

Kaduwaa, North Lore District (1°27' S, 120°19' E, elev. 1,055 m): Kaduwaa focus #13 was situated in an abandoned paddy field with a cover of dense, short marsh grasses. The soil was wet and standing pools of water were scattered about. One side bordered actively worked rice fields, while another side bordered a small stream. The oncomelanid population was dense and associated with *Gyraulus* sp. and *Radix* sp. This area was used as a pasture for domestic animals.

Wanga, North Lore District (1°28' S, 120°19' E, elev. 1,055 m): Wanga focus #14 was located near the trail from Kaduwaa to Wanga. This focus was a small field of dense, high marsh grasses surrounded by scrub-type vegetation and trees. Oncomelanids were plentiful and found in association with *Radix*

sp., *Gyraulus* sp. and *Melanooides* sp. Domestic animals were pastured on this focus.

Wanga focus #15 was a long (500 meters) and narrow focus with a cover of dense, high-marsh grasses at least 500 meters away from the nearest trail and only 2 km from Lake Wanga. The oncomelanid population was dense and *Radix* sp. was the only other mollusk found. This focus did not appear to be used for grazing domestic animals, nor was it often traversed by local inhabitants.

DISCUSSION

Oncomelania hupensis, the subspecific taxa of which are still being investigated, is widely distributed throughout disturbed areas of the North Lore District, Napu Valley; however, no attempt was made to isolate foci in natural habitats. In the adjacent Lindu Valley, oncomelanid foci were found in a variety of habitats, not only in disturbed areas but throughout the virgin forests on the valley floor and in ecotonal areas between the virgin forest and cultivated fields or the lake shore (Sudomo and Carney, 1974).

In other areas at similar or lower elevations along the course of the Lariang River (Fig. 9), as it drains into the Strait of Makassar, human surveys were conducted, but indigenous cases of *S. japonicum* were not found (Carney *et al.*, 1974b; Van Peenen *et al.*, unpublished data). A similar situation was found in the adjacent Gumbasa River drainage system, where no indigenous cases were found in Kulawi or Palu Valleys (Cross *et al.*, unpublished data). In the Palu Valley (Fig. 9), downstream from the well established Lake Lindu focus, *S. japonicum* was not found in small mammals, nor was *O. hupensis* discovered after one year of constant surveillance. (Van Peenen *et al.*, unpublished data).

In Central Sulawesi there was considerable local interest in schistosomiasis since an irriga-

tion project, designed to inundate 12,000 hectares of the Palu Valley, is scheduled for completion in 1976. According to Van Peenen *et al.*, (unpublished data) schistosomiasis is not being transmitted in the Palu Valley. Climatic conditions in the northern portion of the valley near the Bay of Palu probably preclude the natural establishment of *O. hupensis*. This area is one of the driest, if not the driest, in the Indonesian Archipelago as monthly rainfalls average less than 60 mm throughout the year (Schmidt and Ferguson, 1951). However, with the completion of the irrigation project and initiation of perennial irrigation, marshy areas near rice fields could support oncomelanid populations. In the southern portion of the valley habitats similar to those in Lindu Valley are available and climatic conditions appear more favorable for the establishment of *O. hupensis*, if introduced.

Oncomelania hupensis and *S. japonicum* are still known to occur only in the North Lore District of Napu Valley and in Lindu Valley, both of which have a similar geological history and are near or above 1,000 meters in elevation. Reasons for the apparent altitudinal zone restriction of oncomelanids in Sulawesi remain a mystery. Oriental schistosomiasis is usually considered a lowland disease. Outside of Sulawesi foci of oncomelanids at a comparable elevation occur on the island of Mindanao in the Philippines (Pesigan *et al.*, 1958) and in Taiwan *O. h. formosana* is found in mountainous regions of the Kausiung area between 500-700 meters in elevation (Fan and Khaw, 1969).

Potential oncomelanid habitat in Napu Valley is far greater than that available in Lindu Valley. In Lindu Valley less than 50 km² are lowlands or moors needed for *O. hupensis* habitat, whereas in Napu Valley there are 7,500 km² of such terrain (Carney *et al.*, 1974a).

Schistosomiasis has not been reported from the Minahasa peninsula (the northern arm of Sulawesi) which is geographically near Mindanao, Philippines. Stool surveys, to our knowledge, have not been conducted there, nor have samples of the fresh water molluscan fauna been examined by competent authorities. The Minahasa peninsula should be the object of intensive stool examinations and fresh water molluscan surveys in the immediate future.

According to Davis (1969) the genus *Oncomelania* probably originated on the China mainland and spread to Taiwan before it was a separate island. He likewise speculates that *Oncomelania* was later introduced to Japan and the Philippines from mainland China or northern Taiwan by human activities, such as rice culture. The presence of oncomelanids in isolated high mountain valleys of Sulawesi, however, is not as easily attributed to man's activities. Wet rice culture was not introduced into the Lindu Valley until the turn of the century (Gloria Davis, personal communication), and intensive studies in the Lindu Valley have demonstrated that *S. japonicum* and its oncomelanid host are well established in the virgin lowland forests surrounding the lake (Sudomo and Carney, 1974). Humans, most likely, were exposed much less before colonial authorities moved small bands of these Western Torajans to the vicinity of present villages and introduced them to wet-rice culture. Undoubtedly, however, adult males hunted deer and pigs in lowland forests of the valley floor and were there exposed to *S. japonicum*.

SUMMARY

Fifteen colonies of *Oncomelania hupensis* were found near trails transecting the North Lore District, Napu Valley, Central Sulawesi. Habitats were in abandoned rice fields, uncultivated grazing areas for livestock, road-

side ditches and, in one case, an actively worked rice field. Marsh grasses, *Ischaemum barbatum* and *Laersia hexandra*, were the most common plants in oncomelanid habitats. Other mollusks found in association with *O. hupensis* were *Radix* sp., *Melanoides* sp., *Gyraulus* sp., *Idiopoma* sp., *Thiara* sp., *Opeas* sp. and *Indopyrgus* sp. in that order of frequency.

Schistosoma japonicum cercariae, as determined by mouse exposures, were shed from snails collected at four foci.

In Sulawesi, *O. hupensis* and *S. japonicum* were found in high mountain valleys near, or above, 1,000 meters in elevation. *Oncomelania hupensis*, however, were not found in what appeared to be suitable habitats at lower elevations in the same drainage systems.

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